

BRIDGE DESIGN CRITERIA

May 7, 2003

A. Design Specifications

1. American Association of State Highway and Transportation Officials AASHTO LRFD Bridge Design Specifications Second Edition, 1998 with Interims through 2001.
2. Colorado Department of Transportation (CDOT) Bridge Design Manual, May 1992 Edition with revisions through 1998 and Technical Memorandums 1 through 28.
3. Colorado Department of Transportation (CDOT) Computer Aided Drafting Manual, January 1996 Edition with revisions through 2000.
4. Colorado Department of Transportation (CDOT) Bridge Rating Manual, 1995 Edition
5. American Association of State Highway and Transportation Officials "Guide Specifications for Design and Construction of Segmental Concrete Bridges" Second Edition, 1999.
6. CEB-FIP Model Code for Concrete Structures, Third Edition, 1978, Appendix E: Time Dependent Behavior of Concrete, Creep and Shrinkage.

B. Design Method

1. Superstructure

The superstructure shall be designed for applicable strength, service, extreme event and fatigue limit states as defined by the load groups in the LRFD Specifications.

2. Reinforced Concrete Substructure

The substructure shall be designed for the applicable strength and extreme event limit states as defined by the load groups in the LRFD Specifications and checked for the crack control provisions in Section 5.7.3.4 of the Specifications.



3. Foundation Elements

Foundation elements shall be designed for the applicable strength, service and extreme event limit states as defined by the load groups in the LRFD Specifications.

C. Design Loads

1. Permanent Loads (DC, DW, EH, EV, ES, EL)

- a. Unit Weight of Reinforced Concrete: 150 pcf
- b. Unit Weight of Soil: 120 pcf
- c. Horizontal Earth Pressure in Accordance with Geotechnical recommendations
- d. Wearing Surface: 35 psf (Hot Bituminous Pavement Wearing Surface)

2. Live loads (LL, IM, CE, BR, LS)

- a. HL-93 with Impact (Design Truck or Tandem with Design Lane Load)
- b. Colorado Permit Vehicle simultaneously with adjacent HL-93 Lanes (Strength II Load Group)

3. Wind Loads (WS, WL)

In Accordance with “AASHTO LRFD Bridge Design Specifications”

4. Thermal Forces (TU, TG, FR)

- a. Mean Temperature: 50 °F
- b. Thermal Coefficient: 0.000006 / °F
- c. Seasonal Variation:

Temperature Rise:	70 °F	Steel Structures
	30 °F	Concrete Structures
Temperature Fall:	80 °F	Steel Structures
	50 °F	Concrete Structures
- d. Temperature Gradient: In Accordance with “AASHTO LRFD Bridge Design Specifications”, Zone 1

5. Creep and Shrinkage (CR, SH, FR)

In Accordance with “AASHTO LRFD Bridge Design Specifications.” Strains computed in accordance with CEB-FIP “Model Code for Concrete



Structures”, Third Edition, 1978, Appendix E: Time Dependent Behavior of Concrete, Creep and Shrinkage.

6. Fatigue

Fatigue Load Frequency: 792 trucks per day
7. Extreme Events (EQ, CT)
 - a. Earthquake Effects in Accordance with "AASHTO LRFD Bridge Design Specifications", Seismic Performance Zone 1
 - b. Vehicular Collision Forces in Accordance with "AASHTO LRFD Bridge Design Specifications"

D. Materials

1. Superstructure Concrete
 - a. Prestressed Concrete: Class S or PS, $f'_c=8500$ psi maximum
 - b. Reinforced Concrete: Class D, $f'_c=4500$ psi
2. Structural Steel

AASHTO M 270 (ASTM A 709), Grade 50
3. Substructure Concrete
 - a. Abutments, Piers and Footings: Class D, $f'_c=4500$ psi
 - b. Drilled Shafts: Class BZ, $f'_c=4000$ psi
4. Driven Piles

AASHTO M 270 (ASTM A 709), Grade 36
5. Reinforcing Steel
 - a. ASTM A615 Grade 60

All reinforcing steel above the footings, including the column dowel bars shall be epoxy coated.
 - b. Concrete Cover (Unless Shown Otherwise in the Plans):

Superstructure:

 1. Top of Deck: 2 in.
 2. Bottom of CIP Decks: 1 in.



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|--|---------------|-----------------------------|---------|
| | 3. | Precast Elements: | 1 in. |
| | 4. | Other Exterior Surfaces | 1 ½ in. |
| | 5. | Other Interior Surfaces | 1 in. |
| | Substructure: | | |
| | 1. | Surfaces Cast Against Forms | 2 in. |
| | 2. | Surfaces Cast Against Earth | 3 in. |
6. Prestressing Steel
- a. Strand: ASTM A-416, Seven wire Grade 270, Low Relaxation
Prestressing Parameters:
- | | |
|--------------------------|---|
| Strand Size | 0.5" or 0.6" Diameter |
| Apparent Modulus | 28,000 ksi |
| Maximum Jacking Stress | 203 ksi
(75% of Ultimate) |
| Maximum Anchoring Stress | 189 ksi
(70% of Ultimate) |
| Anchor Set | 3/8 in. |
| Friction Coefficient | 0.25 |
| Wobble Coefficient | 0.0
(External Tendons)
0.0002
(Internal Tendons) |
- b. Bars: ASTM A722, Grade 150
Maximum Anchoring Stress 105 ksi
(70% of Ultimate)

E. Allowable Stresses

1. Superstructure

a. Prestressed Concrete

Temporary Stresses before Losses:

Compression: $0.6 f'_{ci}$

Tension: $0.0948 \sqrt{f'_{ci}}$ (ksi)
 $(3\sqrt{f'_{ci}})$ (psi)

Stresses at Service Limit State:

Compression: $0.45 f'_c$ Dead Load Plus
Prestressing



$\phi_w 0.6 f'_c$ All Other Load Cases.

ϕ_w as per Section 5.7.4.7 of the LRFD Specification.

Tension: $0.0948 \sqrt{f'_c}$ (ksi)
 $(3 \sqrt{f'_c}$, psi)
 (post-tensioned with bonded mild reinforcing)

$0.190 \sqrt{f'_c}$ (ksi)
 $(6 \sqrt{f'_c}$, psi)
 (pre-tensioned)

b. Reinforced Concrete

Designed for the applicable strength and extreme event limit states as defined by the load groups in the LRFD Specifications and checked for the crack control provisions in Section 5.7.3.4 of the Specifications.

c. Structural Steel

Designed for the applicable strength and extreme event limit states as defined by the load groups in the LRFD Specifications and checked for the service limit state provisions of Section 6.5.2 and the fatigue and fracture provisions in Section 6.6 of the Specifications.

2. Reinforced Concrete Substructure

Designed for the applicable strength and extreme event limit states as defined by the load groups in the LRFD Specifications and checked for the crack control provisions in Section 5.7.3.4 of the Specifications.

3. Foundation Elements

In Accordance with Geotechnical Investigation Recommendations.

